73rd MORSS CD Cover Page

712CD

For office use only 41205

UNCLASSIFIED DISCLOSURE FORM CD Presentation

21-23 June 2005, at US Military Academy, West Point, NY

Please complete this form 712CD as your cover page to your electronic briefing submission to the MORSS CD. Do not fax to the MORS office.

Author Request **(To be completed by applicant) - The following author(s) request authority to disclose the following presentation in the MORSS Final Report, for inclusion on the MORSS CD and/or posting on the MORS web site.**

Name of Principal Author and all other author(s): Jeffrey R. Cares

Principal Author's Organization and address:
Alidade Incorporated
31 Bridge Street
Newport, RI 02840

Phone:_401-367-0040_____

Fax:___401-633-6420_____

Email:__jeff.cares@alidade.net_____

Original title on 712 A/B: **Techniques for Intelligence Analysis of Networks**

Revised title:

Presented in (input and Bold one): (**WG7,** CG___, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JUN 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Techniques for Intelligence Analysis of Networks	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Alidade Incorporated**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005. , The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**12**	

ALIDADE
INCORPORATED

Techniques for Intelligence Analysis of Networks

Jeffrey R. Cares

73rd MORSS

ALIDADE INCORPORATED

Intel Analysis of Networks

Main Points

- "Complex Networks" have exploitable properties
  - e.g.: Information Age commercial/social successes
- These exploitable properties have military relevance
  - e.g.: Sense and Respond Logistics (OSD-FT)
- There are significant intelligence analysis manifestations of these properties
- A more satisfying theory of Networked Competition (than currently exists for NCW/NCO, etc) is emerging from this research

ALIDADE INCORPORATED

Intel Analysis of Networks

Network Metric Thumb Rules

Experimentation and Analysis

Metric	Range	Operational Significance
Number of nodes, n	n > ~100	Network effects unlikely to occur with n < 50
Number of links, l	l < ~2n	l << 2n, too brittle l >> 2n, too much overhead
Degree distribution	Skewed	Adaptivity, modularity
Largest hub	< 100 links	Hub appears, recedes by reconnection 5% of links
Average path length	log(n)	Short distances even for large networks (e.g., 10^4 nodes → Average path length = ~4)
Clustering	Skewed	Hierarchy, organization
Betweenness	Skewed	Cascade control
Path horizon	log(n)	Self-synchronization
Susceptibility/ Robustness	Low (random removal) High (focused removal)	Hubs should be kept obscure until needed, damage abatement/repair schemes
Neutrality Rating	(0, 1)	Increased network effects, decreased susceptibility, tipping points
Coefficient of Networked Effects	(0, 1)	Network effects PFE/n

ALIDADE INCORPORATED

Intel Analysis of Networks

Number of Nodes, Links

- A factor in how many links are required for adaptive behavior
  - A very large number of nodes with low link density suggests a brute force strategy
  - A very large number of nodes with high link density suggests confusion
  - A very small number of nodes with high link density suggests tight-knit cabal
  - A very small number of nodes with low link density suggests a brittle organization
- Potential Strategy
  - Drive the link/node ratio in a direction counter to what the target organization may need for assumed mission

ALIDADE INCORPORATED

Intel Analysis of Networks

Degree Distribution

- Skewed: Adaptive, Learning Organization
  - Hubs can be kept obscure until needed
  - Hubs can recede, re-appear with re-wiring of 5-10% of links
  - All paths to hubs are short
- Uniform (Lattice): Strict Hierarchy
  - As average degree tends toward 1 organization becomes more "chain-like" and brittle
- Multi-modal: Dispersed Operations
- Potential Strategies
  - Skewed: encourage hub formation, follow short paths
  - Uniform: reduce average degree (increase brittleness)
  - Multi-modal: Divide and conquer

ALIDADE INCORPORATED

Intel Analysis of Networks

Clustering

- High: Small World Effect
- Low: Strict Hierarchy
- Skewed: Adaptive
- Potential Strategies
  - High: Follow short paths to target nodes
  - Low: Drive toward brittleness
  - Skewed: Look for "President's Cluster"

ALIDADE INCORPORATED

Intel Analysis of Networks

Betweenness

- Nodes with high betweenness are nodes through which the highest number of shortest paths pass
- Potential Strategies
  - Bombard the target network with noise to flush out high betweenness
  - Keep high betweenness nodes alive until the target network needs them most
  - Look at low degree nodes close to high betweenness for gatekeeper-protected node relationships

ALIDADE INCORPORATED

Intel Analysis of Networks

Path Horizon

- Very Low: Tight coordination
- Log(*n*): Adaptive
- High: Chains
- Potential Strategies
  - Very Low: Bombard with noise
  - Log(*n*): Induce different structure on network
  - High: Interdict

CNE (*h*-cycles)

- Low *h*: Tight coordination
- High *h*: Chain
- Potential Strategy:
  - Low *h*: bombard with noise
  - High *h*: Remove links to turn into low *h* and then bombard with noise

Conclusions

- Structural Analysis is a useful tool for understanding networks
- Strong complement to traditional methods
- Provides recommendations for how to attack or influence the target network
- Most examples are from non-military contexts
  - Need for military-specific research

ALIDADE
INCORPORATED

Complex Systems Research

Process Innovation & Analysis

Strategic Investment Advice

Future Concept Generation

Corporate/Government War Games & Events

Questions?